Evaluation #2 Energy and rates February 25, 2014 **Name:** Sol.

1. List four different disadvantages associated with the use of fossil fuels.

- non-Renewable source
- low efficiency
- produces greenhouse gases (CO_2) that can lead to smog and acid precipitation.
- need to be refined and transported to the source
  (toxic byproducts) (inconvenient)

2. State Hess's Law. Explain how it can be applied to find the enthalpy change of a reaction.

- It states that the enthalpy of a reaction is independent of the pathway the reaction takes, but depends only on initial and final conditions
- The enthalpy change of a reaction can be determined using different methods ① using $\Delta H°_f$ formation or ② manipulating several several equations

3. Write the equation for the formation of ethanol C_2H_5OH.

$$2\,C_{(s)} + 3\,H_{2(g)} + \tfrac{1}{2}O_{2(g)} \rightarrow C_2H_5OH$$

4. Use *the following information to answer the next question.*

During the purification of nickel, nickel and carbon monoxide react to form nickel tetra carbonyl. $Ni(s) + 4\,CO(g) \rightarrow Ni(CO)_4(g)$ $\Delta_r H^0 = -189.88$ kJ/mol

What is the enthalpy of formation of CO, if enthalpy of formation of Ni $(CO)_4$ and Ni(s) is −632 kJ/mol and 0.00 kJ/mol respectively?

$$\Delta H = \Delta H_f^\circ Ni(CO)_{4(s)} - 4\,\Delta H_f^\circ CO_{(g)}$$

$$-189.88 = -632 - 4\,\Delta H_f^\circ CO$$

$$4\,\Delta H_f^\circ CO = -632 + 189.88$$

$$\Delta H_f^\circ CO = \frac{-442.12}{4}$$

$$\Delta H_f^\circ CO = -110.53$$

$$\approx -111\ kJ/mol$$

5. *Use the following information to answer the next question.*

Consider the following reactions:

(1) $2C_2H_4O(\ell) + 2H_2O \rightarrow 2C_2H_6O_{(l)} + O_2(g)$ $\quad \Delta H = 715.6$ kJ

(2) $2CO_2(g) + 2H_2O(g) \rightarrow C_2H_4O(\ell) + \frac{5}{2}O_2(g)$ $\quad \Delta H = 2042.2$ kJ

Calculate the enthalpy change for the reaction:

$C_2H_6O(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(\ell)$

C_2H_6O Right: Flip (1) $\times \frac{1}{2} \Rightarrow C_2H_6O_{(l)} + \frac{1}{2}O_2 \rightarrow C_2H_4O_{(l)} + H_2O$

$\Delta H_1 \times \frac{1}{2} = -357.8$ kJ

skip O_2:

$2CO_2$ on Left. Flip (2) $\Rightarrow C_2H_4O + \frac{5}{2}O_2 \rightarrow 2CO_2 + 2H_2O$

$(-1) \times \Delta H_2 = -2042.2$ kJ

$C_2H_6O + 3O_2 \rightarrow 2CO_2 + 3H_2O$

$\Delta H = -357.8 - 2042.2$

$= -2400.$ kJ

6. Consider the chemical reaction below

$4\,NH_3(g) + 5\,O_2(g) \rightarrow 4\,NO(g) + 6\,H_2O(g)$

(0, 3.5)
(3, 1.6)

Initially, 3.5 moles of NH_3 are placed in a 4.0 L reaction chamber. After 3.0 minutes only 1.6 moles of NH_3 remain.

a) Calculate the average rate of reaction with respect to NH_3.

b) Calculate the rate at which H_2O is being formed.

or $\frac{1.9\,mol}{3\,min}$

$0.63\,\frac{mol}{min}$

a) average rate $= \frac{\Delta[NH_3]}{\Delta t}$

$= \frac{\left(\frac{3.5\,mol}{4L} - \frac{1.6\,mol}{4L}\right)}{0 - 3}$

$= \frac{0.875 - 0.4}{-3}$

$= -0.15833$ mol/L.min

or $\frac{0.63\,mol}{1\,min} \times \frac{1\,min}{60\,s}$

$= 0.011\,mol/s$

Average rate $= 0.16\,\frac{mol}{L.min}$ or $0.0027\,\frac{mol}{L.s}$

b) rate for $H_2O = 1.5 \times 0.16$

$= 0.24$ mol/L.min

7. What ~~mass of~~ energy propane would ~~have to be burned~~ come from burning to heat a 6.0 kg of steel barbecue from 25°C to 210°C if the heat transfer is 52 % efficient? The specific heat capacity of steel is 0.46 J/g°C.

$Q = 6000\,g \times 0.46 \times (210-25)$ (185)

$= 510600\,J$

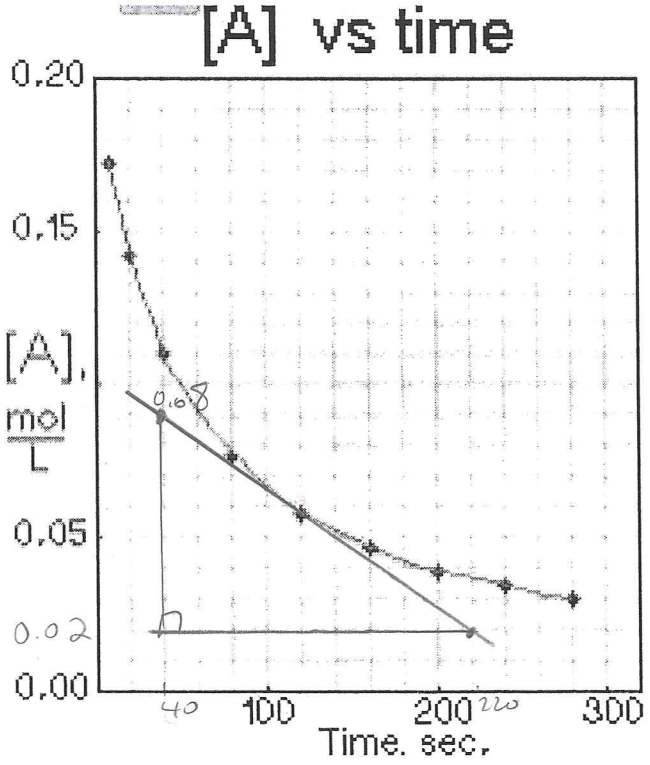
$Q_{of\ combustion} = Q_{absorption}$ but need to account for efficiency

$= \frac{510600}{0.52}$

$= 981923.077\,J$

$\approx 9.8 \times 10^2\,kJ$

8. Find the instantaneous rate at 120 seconds.



slope $= \frac{0.02-0.08}{220-40}$

$= -0.000333$

Instantaneous rate @120 is $3.\times10^{-4}\ \frac{mol}{L.S.}$